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Maximising the benefits of participatory climate adaptation research by understanding and managing the associated challenges and risks

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ABSTRACT

Participatory research approaches are increasingly advocated as an effective means to produce usable climate adaptation science, and increase the likelihood that it will be beneficially incorporated into decision-making processes. However, while the implementation of participatory research approaches, such as those associated with knowledge co-production, have become increasingly commonplace, to date there has been little consideration given to the challenges and subsequent risks associated with their use. To start to address this gap we review the literature on participatory research in climate adaptation science. In doing so we identify and articulate several challenges, and subsequent risks, created by participatory research approaches to adaptation (i) science, (ii) scientists and scientific institutions, (iii) decision-makers and decision-making institutions and (iv) research funders. Based on this we identify seven strategies to help manage these challenges and reduce the associated risks: (a) choose participants carefully; (b) monitor team composition and adjust as necessary; (c) set clear expectations, and agreed conflict resolution mechanisms; (d) use different modes of scientific inquiry that can account for different knowledges and biases; (e) incorporate mechanisms for independent review at all stages of research; (f) reimagine professional development for adaptation researchers, and (g) ensure that appropriate institutional support is in place. These strategies can help to increase the likelihood that participatory research approaches will achieve their goal of generating knowledge that will help society successfully navigate modern day sustainability challenges, such as those posed by climate change.

1. Introduction

Anthropogenic climate change is widely considered to be one of the greatest threats facing humanity (e.g. Nicholls and Cazenave, 2010; Wheeler and von Braun, 2013; Tai et al., 2014; Pecl et al., 2017). Despite global efforts to ameliorate climate changes via the mitigation of greenhouse gases, historical and ongoing emissions mean that impacts from climate change are already occurring and further impacts are now unavoidable (Millar et al., 2017; IPCC, 2018). As a result, adaptation has rapidly emerged as one of the biggest global agenda items of the 21 st century to help safeguard human well-being and prosperity into the future (Adger et al., 2003; Howden et al., 2007; IPCC, 2014).

The growing acknowledgement of the importance of adaptation to address climate variability and change has been accompanied by increasing research effort to support adaptation decision-making (Howden et al., 2014; Frusher et al., 2014). Commonly termed 'adaptation science' (*sensu* Meinke et al., 2009), much of this research has focused on identifying and assessing the threats, risks, uncertainties and opportunities associated with climate change, to generate the knowledge and insights required to effect change in socio-ecological systems that will increase their adaptive capacity and performance. This is typically achieved by analysing problems without a predefined disciplinary lens so as to allow for the inclusion of multiple perspectives and knowledge systems (scientific-, local-, cultural-, experiential-knowledge, etc.) to generate pathways to support decision-makers in navigating the full suite of socio-ecological complexities and uncertainties associated with adapting to climate change (Haasnoot et al., 2013; Butler et al., 2014; Wise et al., 2014).

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Despite the applied nature of adaptation science, and a significant increase in its production over the past two decades, the uptake and integration of new adaptation knowledge into decision-making processes remains limited (e.g. Cvitanovic et al., 2014a; Runhaar et al., 2018). This may, in part, result from the key uncertainties associated with adaptation science, meaning a clear course of action is not necessarily evident to decision-makers. For example, the quantity of academic publications that purport to have decision-relevant insights is high, and includes overlap of topics and conflicting recommendations (O'Leary et al., 2016). Navigating this inefficiency is time-expensive and confusing for decision-makers. When a relevant study is identified, the difficulties continue as there are uncertainties in the global climate models on which adaptation options are premised (Ramirez-Villegas et al., 2013; Grose et al., 2014) and choosing downscaling methods and models that appropriately inform finer scale adaptation options is complex (Hewitson et al., 2014). This complexity is further compounded by the variation in how different researchers define and thus consider adaptation options, which may lead to researchers becoming advocates for their own work rather than promoting the broader array of adaptation options that are actually available (Lacey et al., 2015). Finally, a number of well documented structural impediments and barriers to knowledge exchange between adaptation scientists and decision-makers persist. This includes, but is not limited to, scientific content being 'locked' behind journal paywalls and the time lags between data collection and availability (Cvitanovic et al., 2015a). While such challenges are not unique to climate adaptation science (e.g. Evans et al., 2017), they represent significant barriers to the capacity for decision-makers to implement science-informed adaptation measures.

As a means to produce more usable climate adaptation science (Dilling and Lemos, 2011), and increase the likelihood that it will be beneficially incorporated into decision-making processes, there has been a trend towards the implementation of participatory research approaches for generating adaptation science (Meadow et al., 2015; Klenk et al., 2017). While the concept of participatory research can be defined in various ways, we use the term here to describe the process of securing the active involvement of a broad range of stakeholders such as policy-makers and other users in the generation and use of climate adaptation science (following Few et al., 2007). This is based on the belief that when implemented effectively, participatory research approaches enhance the extent to which scientific processes are perceived by stakeholders as credible and legitimate, increasing the potential for the information produced to be trusted and accepted by diverse stakeholder groups (Cash et al., 2006; Reed, 2008). An important perspective on participatory research points to the underlying philosophy of the research approach being what differentiates it from more conventional academic research. "[T]he key element of participatory research lies not in methods but in the attitudes of researchers, which in turn determine how, by and for whom research is conceptualized and conducted" (Cornwall and Jewkes, 1995 p. 1667). In other words, stakeholders are not just participants in the process, they are the reason for the research process – developing solutions to their problems is the core function of participatory research. Additionally, participatory research approaches can help adaptation science integrate the multiple perspectives and knowledge critical to decision-relevant research so as to tailor adaptation strategies to the needs of research users and the social-ecological contexts for its application (Adger et al., 2005; Cornell et al., 2013).

Despite increased advocacy for the implementation of participatory research approaches in relation to climate adaptation, our understanding has remained largely uncritical (Lemos et al., 2018). While significant and important advances have been made in relation to (i) developing a typology of participatory research approaches (e.g. Meadow et al., 2015) and (ii) identifying the underpinning characteristics that are required for the implementation of successful participatory research approaches (e.g. van Kerkhoff and Lebel, 2015; Wyborn, 2015; Beier et al., 2016), comparatively fewer studies in the climate adaptation literature have sought to critically evaluate or understand the extent to which participatory research approaches pose additional challenges and risk to participants involved in the process (but see Harris and Lyon, 2014; Gaziulusoy et al., 2016). Understanding the suite of potential challenges associated with participatory research approaches is critical for identifying the subsequent risks, and developing strategies to manage these so as to enhance the likelihood that participatory climate adaptation research will meet its desired goal of helping society successfully navigate modern day climate challenges.

To address this gap, we draw on the published literature (via a narrative review informed by our own experiences working within climate adaptation participatory research projects) to identify and explicate potential challenges created through participatory research to climate adaptation science, key actors groups including scientists and policy-makers, and research funders. While we acknowledge that there are other societal actors who can (and should) play a critical role in participatory adaptation research processes, for whom there are also risks that should be considered, we choose to focus on these three types of actors in this instance to allow for the detailed exploration of key issues and to identify specific strategies for managing the identified risks. We hope that by starting to explore these issues we will encourage researchers and practitioners to undertake future research to understand how the risks associated with participatory research are increased for other actors, and identify strategies for how they can be managed.

In writing this manuscript we acknowledge that the interface between science and policy is highly contextual and varies widely across geographies, cultures and temporal scales. Our goal in writing this manuscript is not to provide an in-depth analysis at any of these specific interfaces, but rather, to identify the potential challenges associated with participatory research more generally, and propose strategies for managing them, to help maximise the benefits resulting from participatory climate adaptation research processes (following Lacey et al., 2018). In this article we characterise these challenges through the language of 'risk', as this infers that the challenges can be both known and managed, though the level of concern about risk will differ depending on how it is perceived (e.g. Slovic, 1987). We also acknowledge that this manuscript is informed by our personal experiences working primarily within Western cultures and developed nations, and thus the recommendations are most applicable within comparable research contexts, with potentially limited application to other contexts. To this end, we encourage other researchers and practitioners who are engaging in participatory adaptation research in different cultural settings and sectors to build on our efforts here and similarly share their experiences. Finally, while we focus our examples on climate adaptation, many of the challenges identified, and solutions posed, are likely to be applicable across all fields of participatory sustainability science.

We first (Section 2) provide a brief overview of participatory research to understand its origins and how it has evolved into practice in relation to climate adaptation research. This includes a review of the posited benefits associated with the implementation of participatory research approaches. Then (Section 3), we explore the potential challenges and risks associated with participatory research approaches to adaptation (i) science, (ii) scientists and scientific institutions, (iii) decision-makers and decision-making institutions, and (iv) research funders. Finally, in Section 4, we identify a range of strategies for managing the risks to increase the likelihood of success for participatory climate adaptation research.

2. Overview of participatory research

2.1. A short history of participatory research

Participatory research is an approach that involves the active engagement of diverse stakeholders in the research process. Participatory approaches to research arose as early as the 1940s (Lewin, 1946; Tax, 1958) as a response to positivistic notions in the sciences that excluded

many voices and sources of knowledge, particularly local, indigenous, gender, and ethnic minority knowledges (Brown and Tandon, 1983; Park et al., 1993; Greenwood and Levin, 2007; Wallerstein and Duran, 2008). A set of research approaches – including action research, participatory action research, practitioner research, emancipatory research and community-based participatory research – has developed since that time to address a variety of social, environmental and health problems facing on-the-ground stakeholders and decision-makers. The whole suite of participatory research approaches intends to make research both more democratic, through stakeholder involvement, and impactful, by tying it to actions that benefit those stakeholders (Reason and Bradbury, 2008a; Wallerstein and Duran, 2008).

With the overarching goal of enabling informed change by engaging different stakeholder groups within research activities (reviewed by Khanlou and Peter, 2005), participatory research focuses on engaging decision-makers and other stakeholders in research, not as subjects, but as co-producers of knowledge (Greenwood and Levin, 2007; Reason and Bradbury, 2008b). While this aspiration for egalitarian partnerships is not always met in practice (Wiber et al., 2004), the principles underlying this branch of research centre on notions of equality, co-production, and social and environmental justice, enacted through a mutually respectful and beneficial *relationship* between researchers and research stakeholders.

Stakeholder involvement in research can take a number of forms starting with low levels of engagement such as providing data for a research project or providing evaluative feedback on research products (i.e., consultation), to higher order engagement where research stakeholders inform the development of research questions and contribute to the setting of research agendas (Fig. 1) (Reed et al., 2017). Consultative approaches, however, can be limited in their use given that stakeholders often remain a source of information for use by researchers, rather than partners in the research process. As a result, these approaches do not guarantee the full development of the relationship between the producers and users of research, potentially undermining the extent to which the benefits of participation are conferred (see Section 2.2).

It was these shortcomings that encouraged the development of the broad field of participatory research. The practice developed largely in the social and health sciences, but in more recent decades, the practice has been explored in the biophysical and environmental sciences as a way to address increasingly complex environmental problems like climate change adaptation. Co-production of knowledge (Jasanoff, 2004) has become a common term within the climate change adaptation field used to capture the idea that solutions to complex problems require interaction and co-production of solutions between science (researchers) and society (stakeholders). In this model, researchers and research stakeholders interact directly via trusting relationships and with shared goals. A recent review of the literature by Bremer and Meisch (2017) showed significant increases in the number of publications relating to climate change and co-production over the past two decades. Similarly, Meadow et al. (2015) also note the proliferation of supposedly co-produced climate knowledge.

Participatory research can also be facilitated through intermediaries such as boundary organisations (Guston, 2001) and knowledge brokers (Meyer, 2010). While conceptualised differently across sectors and settings, the key feature of these intermediaries is to facilitate the exchange of knowledge between various stakeholders, including researchers, practitioners and decision-makers. This is achieved by developing networks among these groups of stakeholders and facilitating their active involvement within research activities (Reinecke, 2015). Indeed, the use of intermediaries in relation to climate challenges has increased, for example, in the United States with Jacobs (2014) identifying the NOAA Regional Integrated Sciences and Assessments program, the Climate Adaptation Science Centres funded by the Department of the Interior, and the 'climate hubs' of the US Department of Agriculture as recent examples of successful boundary organisations (Bednarek et al., 2018). Similarly, in Australia, recent empirical evidence has shown that a single knowledge broker was able to facilitate a cohesive network of climate scientists and decision-makers to promote increased participation and knowledge sharing (Cvitanovic et al., 2017).

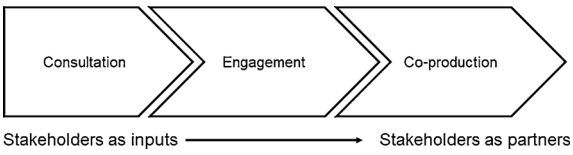

Fig. 1. Conceptual representation showing how the involvement of stakeholders in participatory research can take a variety of forms from consultation to co-production.

Finally, participatory research can also be facilitated via novel institutional structures that 'embed' scientists within decision-making agencies, or vice versa (*sensu* Cvitanovic et al., 2015a). For example, Cook et al. (2013) posit that if decision-making agencies were to permanently embed research scientists within their organisations it would improve the likelihood that priority knowledge gaps will be filled, with the information quickly spreading among decision-makers and informing decisions. In this way the idea of embedding builds on that of knowledge co-production, in that it allows for decision-makers and scientists to collaborate more intensively through all aspects of both the scientific *and* decision-making processes. Furthermore, the embedding approach facilitates the implementation of long term participatory research activities and strategic collaboration across timescales better aligned with the challenges presented by climate change (i.e. beyond the scope of a single project) (Doubleday and Wilsdon, 2012; Reed et al., 2014).

In summary, the core goals of participatory research are to co-produce knowledge and solutions with, and for, decision-makers and other stakeholders. In practice, a continuum of participation may occur, from stakeholders as inputs to research projects through models of co-production where the stakeholders actively partner with researchers in the research process, based on the specific questions and context of any given research project. Means such as the use of intermediaries and boundary organisations and institutional embedding can facilitate the novel and more intensive approaches to participatory research.

2.2. Benefits of participatory research for supporting evidence-informed decision-making

Alongside the development and implementation of the different approaches to participatory research, an extensive body of literature has also emerged outlining a range of benefits associated with their application. One key benefit is that participatory research approaches overcome known barriers to knowledge exchange among scientists and decision-makers to support evidenced-informed decision-making (review by Cvitanovic et al., 2015a). In this section we provide a brief overview of these benefits.

First, participatory research approaches can be an effective way to make science more accessible to decision-makers and facilitate its incorporation in the decision-making processes. For example, studies across different environmental sectors have shown that on average it takes more than three years for scientific articles to be published following data collection (Fazey et al., 2005), and thus information may be out of date and less useful to decision-makers by the time it is made available (Linklater, 2003; Cvitanovic et al., 2016). Furthermore, even when scientific knowledge does become available the majority is retained behind journal subscription paywalls which many decision-making agencies cannot afford (e.g. Cvitanovic et al., 2014b), thus further limiting its accessibility to, and utility in, decision-making processes. To illustrate, a recent analysis by Bornmann et al. (2016) found that only 1.2% of published climate change research has been

cited in policy documents. Participatory research approaches are believed to help overcome these barriers, as the direct involvement of decision-makers and other end-users in the scientific process ensures that the research undertaken is solution-driven and useful for the decision-making context (Bednarek et al., 2018). Additionally, these approaches can help decision-makers develop a real-time and in-depth understanding of the research content, which they can then disseminate quickly and effectively throughout their social networks and organisations as the information emerges (Reed et al., 2014).

Building on this, participatory research approaches are believed to increase the extent to which the outcomes of scientific research are perceived by decision-makers as salient, credible and legitimate (Cash et al., 2003). In this regard, salience describes the extent to which the research outcomes are relevant to decision-makers and specific decision-making contexts, taking into consideration their specific information needs and institutional operating environments (Cash and Moser, 2000). Credibility refers to the extent to which scientific outputs and outcomes are perceived by decision-makers as accurate, valid, robust and of high quality (Cash and Buizer, 2005; Salter et al., 2010) while legitimacy describes the extent to which the knowledge producers (i.e. adaptation researchers) are considered to be bias free and thus trustworthy by decision-makers (Deelstra et al., 2003). In combination, it is believed that these three traits increase the likelihood that scientific outcomes will be incorporated into decision-making processes (Cash et al., 2003), particularly in relation to complex and contested issues such as those associated with climate change and the array of available adaptation options to decision-makers. For example, as detailed in Lacey et al. (2015), there are numerous uncertainties associated with how adaptation options are selected for implementation, such as the choice of appropriate methods for downscaling global or regional models to inform adaptation at the local scale (Hewitson et al., 2014). This, in combination with the ways in which different researchers define and respond to adaptation (e.g. considering technological innovation versus institutional change), creates the risk that researchers may become advocates for their own work without full transparency that their recommendations represent only a subset of the available knowledge and adaptation options that are available. In such cases there is the potential that adaptation science will not be utilised, or will lead to suboptimal outcomes, thus highlighting the importance of salience, credibility and legitimacy in relation to adaptation science.

Next, participatory research approaches can facilitate the inclusion of multiple knowledge systems into decision-making processes (Mauser et al., 2013; Tengö et al., 2017). This is important given that scientific knowledge is only one form of knowledge system that can contribute to informing adaptation decision-making processes, and in recognition that adaptation science is most useful to, and trusted by, decision-makers when considered in conjunction with other forms of knowledge (Cornell et al., 2013; Cvitanovic et al., 2014a). For example, the inclusion of local and cultural knowledge is critical for identifying the most appropriate and culturally sensitive fine-scale adaptation options, and subsequently for understanding how to engage with local communities to promote their uptake (Reid et al., 2009; Gearheard et al., 2010; Naess, 2012; Boillat and Berkes, 2013). Similarly, the inclusion of experiential knowledge is believed to enhance the likely success of decision-making processes as it allows those engaged in participatory research approaches to learn from previous successes and failures (e.g. in relation to the communication and subsequent acceptance of adaptation options by end-users), thus increasing the potential for success of decision-making processes (Fazey et al., 2006). Finally, the integration of expert knowledge through formal expert elicitation techniques can be used effectively to support decision-making under uncertainty and in scenario modelling of uncertain future events, particularly when quantitative scientific evidence is lacking (Hemming et al., 2017; Martin et al., 2012). Thus, bridging diverse knowledge systems through participatory research has also been shown to generate innovative, more inclusive and equitable solutions to sustainability problems, such as those arising from climate change (Mauser et al., 2013).

Finally, participatory research approaches are recognised for their ability to foster learning among participants (reviewed by Gupta, 2016), which we define as 'the process of cognitive change leading to behavioural change, which can manifest at either individual or collective scales' (following Newig et al., 2010). Essential to this shared learning via participatory research is the direct interface between researchers and research stakeholders. By creating a space where the research 'producer' and 'user' build meaningful relationships that break down the intergroup divide – turning 'us and them' into 'we' – researchers and research stakeholders are more likely to experience trust (Lacey et al., 2018), a sense of shared identity and purpose (Fielding and Hornsey, 2016; Colvin et al., 2015), and social influence that increases "receptiveness to the views of those whom we regard as 'one of us'" (Mols et al., 2014, pp.89–90). This relationship building enables learning in the immediate term (e.g. via a distinct project) and in the longer-term (e.g. via ongoing collaboration and interaction) ultimately enhancing outcomes for climate adaptation researchers and research stakeholders alike. Learning is considered particularly important for navigating the uncertain, complex and synergistic challenges presented to society by climate change (Sardar, 2010; Parrott and Meyer, 2012; Picketts, 2018), as it underpins the extent to which decision-makers and their associated governing institutions can respond rapidly, adaptively and flexibly to change (Fazey et al., 2007).

3. Challenges and subsequent risks of participatory climate adaptation research

Arguably, all applied research – in which our suppositions and experiments are subject to real-world tests – is a risky endeavour. We remove the protective boundaries of a tightly controlled laboratory and grapple with the messy world in which science and society interact and intermix constantly. However, participatory research poses some additional challenges because it actively includes multiple perspectives, voices and values in ways that make data collection, analysis and interpretation much more complicated than the traditional laboratory situation. In some cases, these additional challenges may also confer additional risks to the actors taking part in the participatory research process. Thus, as the use of participatory research approaches grows in climate adaptation work, we must consider the challenges and risks in ways that have not yet been done within the climate adaptation community, so as to identify options for managing them, in turn ensuring that adaptation science can fulfil its objective of helping society achieve the transformative changes that are required. To this end, in this section we draw on the existing literature and our own experiences operating in participatory research projects to undertake a critical examination of the challenges associated with participatory research approaches and the risks that they may confer. While our list is not exhaustive, it serves to highlight some of the key challenges associated with participatory research processes about which participants should be mindful.

3.1. Challenges to the scientific process

3.1.1. Compromised scientific integrity

First, participatory research approaches may generate some additional challenges and risks to the scientific process with regards to both the 'quality' and 'utility' of the scientific outcomes, as are commonly understood in the natural and physical sciences where much climate research is based. Every participant engaging in participatory research approaches has a set of beliefs about what constitutes knowledge, how it is produced and how it should be applied (i.e. their epistemological perspective) (Blythe et al., 2017). Participatory research depends on these multiple perspectives – including the unique perspective of the researchers - to increase the external validity of research (i.e. its applicability to solving real-world problems) (Green et al., 2009). However, balancing and incorporating multiple, and possibly contradictory,

perspectives in ways that maintain the credibility of the science poses both philosophical and practical challenges.

The inclusion of multiple participants within the research process and the associated combination of knowledge systems, may appear to compromise the actual and/or perceived integrity of the scientific outputs (Mauser et al., 2013; King and O'Meara, 2018). For example, while it is generally argued that addressing contemporary climate adaptation challenges requires the integration of knowledge systems (e.g. local knowledge, experiential knowledge, cultural knowledge, etc.), non-scientific knowledge can be perceived by some as more susceptible to bias or lacking in credibility. Thus, the inclusion of a diversity of knowledge systems, without careful and ethical research practices, presents a real or 'perceived' risk that biased or un-interrogated beliefs could undermine the perceived rigour of research outputs. This, in turn, could reduce the extent to which decision-makers trust the research outcomes and/or outputs, making it less likely that they incorporate them into their decision-making processes.

3.1.2. 'Containment' of actors

Power imbalances can also play a role in the ways that multiple and diverse perspectives are incorporated credibly in a participatory research process (Few et al., 2007). For example, where epistemological perspectives among participants are mutually exclusive, some forms of knowledge (e.g. scientific, experiential, local) and research methodologies (e.g. quantitative vs qualitative vs mixed-methods approaches) may be disregarded or distrusted by some research participants (Blythe et al., 2017). This has the potential to disrupt the collaborative research effort, and lead to the dominance of one knowledge system over the others (Balvanera et al., 2017). In these situations, the more 'powerful' individuals or groups can consciously or subconsciously steer participation towards support for a specific epistemology, method, or even a predetermined outcome, by forging tactical alliances and blocking dissent; termed 'containment' of participation (Few, 2001, 2003). This means that research outcomes are less likely to have been informed by the full suite of available knowledge, reducing its usefulness to assist in informing adaptation decision-making processes, or potentially leading to maladaptive decision-making processes.

Further, in many cases of participatory research it is those who are managing the participatory process that are in the privileged position of deciding who is considered a legitimate participant and who is not, in turn potentially elevating some perspectives and excluding others (Colvin et al., 2016). Other types of power, too, can influence the success of participatory research. For example, Reed (2016) encourages researchers to consider their relative power in participatory processes, including their situational power (formal, hierarchical, power), social power (privilege due to gender, race, sexuality etc.), personal power (personal traits such as trustworthiness, charisma) and transpersonal power (access to powerful others). Reflecting on power dynamics in a participatory research setting can identify where the reality of - or perceptions about - power creates expectations that can be conducive or inhibiting to effective participatory research. Where power is used to create an unfair advantage for certain groups or ideas, whether intentionally or unintentionally, it puts the legitimacy of the process and the credibility of the science at risk, limiting its utility for decision-making processes and broader societal responses to adaptation.

3.1.3. Tokenistic engagement

There is also a risk that participants could simply be engaged within participatory research approaches on a tokenistic level (Arnstein, 1969) – in which case the research may no longer be considered as participatory. For example, as calls for science to fulfil its societal obligations have increased (e.g. Lubchenco, 1998), so too has the requirement by research funders for research proposals to be 'transdisciplinary', and actively engage decision-makers. It is now commonplace that research proposals are submitted describing a 'high level participation' between the research team and decision-makers (e.g. Watermeyer and Hedgecoe, 2016). However, the extent to which high levels of participation occur in practice may be limited, compromising the overall success of the process and reducing the validity of the outputs and outcomes.

3.2. Challenges for adaptation scientists and scientific institutions

3.2.1. Compromised individual integrity

Participatory research approaches can also present significant challenges to adaptation scientists. For example, as outlined in Section 3.1, the inclusion of multiple epistemological perspectives that results from participatory research approaches has the potential to compromise both the actual and/or perceived integrity of the scientific outputs (e.g. Supran and Oreskes, 2017; King and O'Meara, 2018). In this respect, social science practitioners of participatory research and those beginning to use the approach in climate adaptation are in agreement – the *perception* from other researchers that applied, participatory research is somehow less rigorous or "scientific" is a recurring theme and challenge (Greenwood and Levin, 2007; Polanyi and Cockburn, 2003; Schensul et al., 2014). This has the potential to adversely impact the individual reputation of researchers (e.g. reputational risk) engaged in participatory research processes among their peers and decision-makers in the field. This may, in turn, limit their opportunity to collaborate with peers, or the extent to which their research outputs are trusted and used in decision-making processes outside of the group with whom the researchers directly collaborated with on the participatory research project.

3.2.2. Impacts on career progression

Current incentive systems in academia result in a researcher's reputation being largely dependent on their academic achievements (e.g. quality of their peer-reviewed publications and funding success). It has been shown that research involving multiple epistemological perspectives has consistently lower funding success than more traditional modes of research (Bromham et al., 2016), and is typically more challenging to publish in top tier scientific journals as many journals are discipline-specific and those that are not find it difficult to find reviewers who span multiple epistemological perspectives (Campbell, 2005; Rafols et al., 2012). Given that funding success and publication in top tier journals remain a key measure of academic performance (e.g. Cvitanovic et al., 2015b), utilising participatory research approaches can confer risks to adaptation scientists via impacts to their job security, career progression and success in science.

The implementation of participatory research approaches also has significant complexity and transaction costs (Beier et al., 2016; Balvanera et al., 2017) that can present a number of challenges to career progression among adaptation scientists. Firstly, negotiating the various perspectives of different stakeholders involved in the process (and accounting for their institutional requirements such as approvals and internal review processes) can be time consuming (Polk, 2015). Time spent traveling and attending meetings in addition to the standard travel requirements of research (e.g. field work) also means time away from other competing academic demands (Hoeft et al., 2014). These transaction costs present a risk to scientists as they could ultimately impede progress of scientific outputs by extending the time before publication of results, which as described above, can have subsequent impacts on career success and progression. In contexts where there is poor institutional acceptance of, and support for, extended timeframes associated with participatory research, it may lead to the perception that scientists are 'under-delivering', once again adversely affecting the ability of adaptation researchers to seek permanency or promotion.

3.2.3. Impacts on personal well-being

Closely related to the above, increased process complexity and the associated transaction costs can also impact on the work-life balance of adaptation scientists (Campos-Arceiz et al., 2013). For example,

increased travel requirements and attendance at prolonged meetings and workshops can limit the time that adaptation scientists spend with family and friends. This, in turn, may lead to strained, or lost, relationships. Long and non-typical working hours, such as those associated with excessive travel, are also known to be risk factors for depression and anxiety (Kleppa et al., 2008; Virtanen et al., 2011).

Furthermore, the range of skills and experiences required to navigate and negotiate complex participatory processes (ability to read social cues, navigate complex political settings, etc.) are not taught as part of traditional academic training programs (Bernsten et al., 2017) or considered legitimate forms of academic scholarship (Jacobson et al., 2004). As such, some adaptation researchers might find engaging in such processes particularly challenging and stressful, or even unnecessary, thus limiting their levels of professional confidence and satisfaction. This compounds with existing stressors on personal well-being for researchers, which in a more standard model of science, are already not insignificant (Reevy and Deason, 2014).

3.2.4. Decreased 'trustworthiness'

Engaging in participatory research approaches may also limit the extent to which adaptation researchers are perceived outside of their group as 'honest brokers' (*sensu* Pielke, 2007). As described by Pielke (2007), the notion of honest broker describes a sub-set of scientists who do not advocate for a single cause or pre-determined outcome, but rather consider the full suite of available information to provide factual, empirically-based advice that does not reflect their individual research or epistemological perspective.

In instances where adaptation researchers work closely with specific decision-makers for long periods of time, they might be perceived by other stakeholders and end-users as losing their objectivity, lessening the extent to which they are considered an honest broker, and thus, their potential impact on decision-making processes more broadly. For example, adaptation researchers (and by association their colleagues and institutions) who have collaborated closely with industry may not be viewed as credible by environmental NGO stakeholders or other scientists and institutions who choose not to engage with industry, and vice versa. In such situations, the boundary between researcher and research stakeholder blur to the point where perceptions about the research stakeholder's motives, conduct and credibility are transferred to the researcher, regardless of the nature of scientific integrity and rigour underpinning the researcher's work.

3.3. Challenges to adaptation decision-makers and their institutions

3.3.1. 'Capture' of decision-makers

Participatory research approaches can also present several challenges and risks to decision-makers that engage in them. Firstly, they can increase the likelihood of situations whereby an individual scientist (or group of scientists) 'capture' decision-makers who then continue to support and fund a specific stream of research that aligns to the disciplinary or epistemological lens of that specific scientist group (Lacey et al., 2018). This can have adverse impacts for both individual decision-makers and the broader decision-making agency. For example, for highly complex and uncertain challenges such as those presented by climate change, a focus on singular dimensions of the issue may lead to missed opportunities or even maladaptation (Lacey et al., 2015). This may also lead to increased scrutiny of the individual decision-makers engaged within the participatory research process, and of the broader decision-making agency. This has the potential to adversely impact individual careers and cause individual distress, while potentially also impacting broader societal support for, and trust in, the decision-making institution.

3.3.2. Loss of perceived legitimacy by public

Building on the above, when dealing with controversial and complex issues such as those associated with climate adaptation (Boykoff, 2007), the likelihood of divergent perspectives among participants is heightened. This may lead to dissent among participants and conflict may arise (Colvin et al., 2015). In such cases there is the risk that adaptation researchers, who are not bound by organisational limitations, may speak out publicly in opposition to the decision-makers' public position, leading to a loss of public support for the agency (Picketts, 2018). Where this occurs there are also risks to individual decision-makers associated with distress and mental health, as well as to the broader decision-making agency by affecting the extent to which they are perceived as legitimate by their stakeholders and the broader public (Tyler 2006). However, we acknowledge the important role of researchers in challenging decisions that may go against best available evidence or fail to represent the public good. Nevertheless, when these dynamics arise in a participatory research setting the potential risk to decision-makers is heightened. From the decision-makers' perspective, inviting researchers into the decision-making process necessarily makes the decision-maker vulnerable to researchers with privileged knowledge of the decision context and process using that knowledge to act as powerful adversaries in the public sphere.

3.4. Challenges to adaptation research funders

3.4.1. Increased (potentially unjustifiable) costs

Finally, participatory research approaches can also present additional challenges to funders of climate adaptation research. For example, the increased number of participants, who are also likely to be geographically dispersed, associated with participatory research approaches can lead to increased implementation costs (which is the cost of coordinating implementation and the potential opportunity cost of implementation failure) (Birner and Wittmer, 2004). At the same time it will also increase decision-making costs (cost of acquiring information, cost of coordinating decision making and decision-failure cost) and production costs (technical measures needed to manage the research or implementation of the outputs) (Birner and Wittmer, 2004; Sutherland et al., 2017). Thus, where the benefits achieved through participatory research approaches do not outweigh their additional costs the funders are likely to be increasingly scrutinised with potential impacts to their public credibility, particularly in instances where funding is provided via public monies (e.g. government grant schemes).

Compounding this risk is that many collaborative processes necessitate expenses that may be more open to public critique, compared with traditional laboratory-related costs. This includes costs from catering for workshops and meetings, and the travel and accommodation associated with relationship building as opposed to a physically tangible deliverable. The potential intangibility of the activities, as well as the costs, associated with participatory research may create difficulties for research funders in justifying their funding choices to relevant actors.

4. Strategies to manage risk in participatory research

Despite widespread advocacy for the implementation of participatory research approaches in relation to climate adaptation, we have outlined how they can also present significant challenges and risks to adaptation science, scientists, decision-makers, and funders. Identifying and implementing strategies to reduce and manage these risks is critical to ensure that the perceived benefits of participation are realised. In this section, we review the literature from other sectors where participatory research approaches are commonly implemented (e.g. the medical sector and private sector), to provide insights and strategies for how to manage risk and maximise the potential for success of participatory climate adaptation research (Fig. 2; Table 1). In doing so, however, we reiterate our earlier point that these strategies have been informed by the various experiences of the author group who primarily work within Western and developed cultures and contexts. Thus, their applicability is best suited in comparable contexts, and future work is needed to

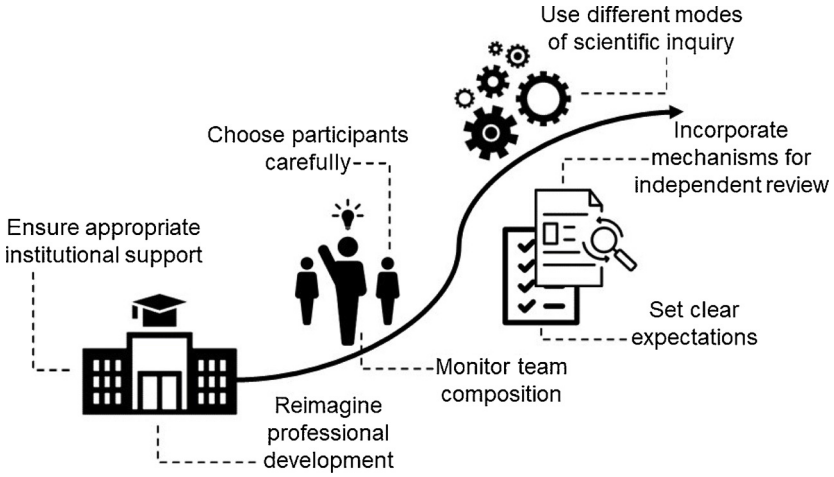

Fig. 2. Visual representation of the seven strategies that can be used to manage the challenges and risks of participatory adaptation research.

understand how they could also be applied across broader cultures and contexts, or what other mechanisms are available for other contexts.

4.1. Choose participants (including researchers) carefully

The level of risk associated with participatory research approaches is largely dependent on the composition of the group. However, it has been shown that achieving an appropriate balance in group composition is highly variable according to individual characteristics of the participants as well as the social and political context within which the science is to be produced (e.g. Eckley, 2002; Farrell and Jäger, 2005). While it is difficult and sometimes undesirable to manipulate and/or change social or political contexts, steps can be taken to ensure that participants display the required individual attributes to minimise risk and maximise the likelihood of success (Timmings et al., 2016). For example, it is critical that all participants, despite their individual epistemological perspectives, are open to the perspective and worldviews of the other participants (Eckley et al., 2001; Evans and Cvitanovic, 2018). It is also critical that the group is sufficiently context specific to represent the perspectives that are relevant to the research or decision context, and that representation across groups is balanced to reduce the likelihood of a power imbalance. In sum, it is important to ensure that access to participatory research is open to all stakeholders with appropriate expertise, reflecting principles of equity of access and inclusion. However, given the necessity of inter-personal trust, it is also important to take seriously the need to address and appropriately deal with participants who may undermine or exclude other participants from a different background during the process (whether it be personal, disciplinary, or otherwise).

Adopting approaches which explicate identification processes is, therefore, important for ensuring all relevant participants are identified, not just those who may be familiar or easily accessible to the adaptation scientists or decision-makers (Colvin et al., 2016). To achieve this, in developing teams the initiators (be they adaptation researchers or decision-makers) could use stakeholder analysis techniques (see review by Reed, 2008) to identify all relevant (i.e. context

Table 1
Summary of the seven strategies that can be used to manage the challenges and risks of participatory adaptation research.

Participatory research risk management strategy	Insights for implementing participatory research risk management strategy
Choose participants carefully	• Include participants who are open and respectful to the perspectives and worldviews of others. • Ensure that the group is context specific, with balanced representation of all relevant stakeholder groups.
Monitor team composition	• Monitor team composition over time to identify (and rectify) sources of conflict and/or power imbalances. • Undertake regular (e.g. annual) stakeholder mapping to ensure that team members are 'representative' of all relevant groups across life of project.
Set clear expectations	• At the onset, jointly set agreed expectations for both the research process and individual behaviours of participants within the process. • Also at the onset of the research activity, identify and agree on a range of internal and external conflict resolution mechanisms should conflict arise.
Use different modes of scientific inquiry	• Where appropriate, use reflexive and interpretive modes of enquiry that directly consider and account for the tensions between different viewpoints. • Use independent facilitation where possible to avoid the overemphasis of a single perspective or knowledge base dominating group discussions.
Incorporate mechanisms for independent review	• Plan (and ensure budget) for independent reviews throughout the entire research process. • Ensure reviews focus on both the overall functioning and dynamics of the team and various participants, as well as research outputs. • Where possible (e.g. within budgetary constraints), include independent reviews from multiple peoples/groups. • Ensure reviews have a strong understanding of the processes and practices of participatory research.
Reimagine professional development	• Research institutions should provide training and capacity develop for adaptation researchers in the full suite of skills required by participatory research, such as those associated with active listening, mediation, brokering, facilitation and translation.
Ensure appropriate institutional support	• Ensure adequate and expert legal and financial support is available to participants during the development of participatory research contracts. • Research institutions should encourage good research practice by clearly defining stakeholder engagement expectations. • Research institutions should recognise and reward the full suite of responsibilities researchers have within participatory research approaches.

specific) stakeholders, the existing relationships that exist among them and the potential level of influence and/or power that they might have in the group.

Appropriate researcher training and capacity development is also a key consideration (Hegger and Dieperink, 2014; Meadow et al. in review; Wiek et al., 2011). Indeed, inadequate preparation and training of researchers to conduct participatory research is a key risk to the process (Grant et al., 2008). Given that effective participatory research depends on transparent and trusting relationships among all team members, it is critical that researchers have adequate communication, facilitation and group-process skills in addition to their research and academic skills (Grant et al., 2008; Addison et al., 2013). Further, Cheruvelil et al. (2014) highlight the ways in which teamwork training (via both formal and informal avenues) can promote a collaborative environment and increase the likelihood of success in solving complex environmental challenges. Thus, by incorporating specific skills that support team building initiatives and activities throughout the project (e.g. informal team meetings, formal team and trust-building initiatives, etc.), collaboration and productivity can be enhanced over the duration of the project.

4.2. Monitor team composition and adjust

Despite best efforts to ameliorate risks via the careful selection of participants, participatory research approaches can be highly dynamic over time, for example; given changing social and political settings, changes in the personal circumstances of participants, or conflicts that may arise (Sarkki et al., 2014). As such, it is critical that the team composition, and the extent to which it is functioning effectively, is monitored and adjusted as needed over time (Djenontin and Meadow, 2018). This could be achieved via the implementation of longitudinal social network analysis (e.g. Cvitanovic et al., 2017), which is a cost effective approach to monitor the role and influence of the various participants according to their 'position' within the overall network, and how these change (Crona and Bodin, 2006; Bodin and Crona, 2009). Schulz et al. (2003) also recommend annual surveys to monitor group dynamics and adjust processes to ensure projects remain productive. Such surveys may include evaluation of whether team members feel they are part of one coherent whole (i.e. a 'we') or see themselves as belonging to a number of fractured groups (i.e. 'us and them') (e.g. Haslam et al., 2003). Doing so will allow for the early identification of potential issues that may emerge, such as 'powerful' individuals or intergroup conflict, so that collective action can be taken to remedy the situation.

Furthermore, ongoing monitoring of the group composition should include regular (e.g. annual) stakeholder analyses to assess whether the participants represent all the relevant stakeholders. This will ensure that even as social and political situations change, all relevant stakeholders groups are correctly represented. While individual team members may change over time in response to the broader needs of the group, because participatory research often depends on long-term relationships, "the goal. . . is to generate networks that are sufficiently strong that members can come and go without threatening the cohesiveness of the overall partnership" (Austin, 2004, P. 427).

4.3. Set clear expectations and agreed conflict resolution mechanisms

Once the team has been identified, it is important to collectively set and agree upon the expectations associated with the participatory research effort. These expectations should look beyond simply agreeing on joint outputs of the research by also focusing on expectations relating to individual behaviours and conflict resolution mechanisms for the entire research process. Indeed, developing conflict resolution mechanisms for highly collaborative groups such as those embodied by participatory research approaches is particularly challenging, given a potential lack of access to external and fully independent conflict-resolution mechanisms (Alston et al., 1999). Thus, agreeing on and documenting a shared set of conflict resolution options at the outset is critical (Margerum, 2002). For example, establishing multi-stakeholder decision-making groups under specific and explicit rules around collaboration and the necessity for productive outcomes was found to facilitate effective participatory decision-making in high-conflict settings (Colvin et al., 2015). Furthermore, given that the majority of climate adaptation research requires research ethics approval, conflict resolution measures could be included within ethics applications so that there are options to seek external support should the conflict not be able to be resolved among the members of the participatory research process (Khanlou and Peter, 2005).

4.4. Utilise different modes of scientific inquiry to address different knowledges and biases

As highlighted through the experiences of social science practitioners of participatory research, reflexive and interpretive modes of inquiry that directly consider the tensions between different viewpoints as part of the research process should be used (Wallerstein and Duran, 2008; Fazey et al., 2018). That is, treating participatory research as a research practice, not a public participation effort – in order to balance and integrate multiple perspectives. For example, using multiple lines of inquiry such as one-on-one interviews, focus groups, surveys and participant observation helps researchers better understand how and why the multiple perspectives exist and provides opportunities to triangulate information and accounts received from participants. This process of triangulation and reflection can also be combined with an iterative and reflexive analysis process involving researchers and stakeholders to ensure that power imbalances are managed and that the different knowledge systems are equally accounted for (e.g. van Kerkhoff and Pilbeam, 2017).

Reflective and interpretive modes of scientific enquiry also point to the need for researchers to consciously encourage all participants to examine their values and views as part of understanding the larger problem and potential solutions. Specifically, and as described by Huntjens et al. (2014), the researcher should play a different role from the stakeholders in order to ensure that the added value of the researcher in the process is maintained. One aspect of that role, according to Greenwood and Levin (2007, P. 54) is that action researchers are "obligated to question [local stakeholders], press their logics and interpretations. . ." and "reflect back to the local group things about them, including criticism of their own perspectives or habits, in a way that is experienced as supportive rather than negatively critical or domineering". Tools like facilitation can also be used to help the group as a whole avoid overemphasis of a single perspective or knowledge base (Mackewn, 2008).

In addition to reflexive and interpretive modes of inquiry, in collaborations designed to support decision-makers through a participatory process, other approaches such as structured decision-making can be used. Structured decision-making involves structured processes for scientists to follow from defining the decision context through to exploring and implementing adaptation options, monitoring and evaluating effectiveness of implemented adaptation activities (Addison et al., 2013). Most importantly these approaches involve facilitation techniques and tools to elicit carefully both factual information (e.g. about the state of the environment) and values (e.g. individual priorities or preferences), whilst accounting for biases and uncertainty within these knowledge systems (e.g., Addison et al., 2013; Hemming et al., 2017).

4.5. Incorporate mechanisms for independent review at all stages of research

In addition to the strategies outlined above that can be implemented by the research team itself, risk in participatory research approaches can be further managed via independent reviews. As reviewed by

Khanlou and Peter (2005), independent reviews ensure that individuals who are unaffiliated with the research project have the opportunity to evaluate the project to ensure that it meets its desired scientific outcomes in an ethical manner, further reducing any potential conflict of interest. In many cases, participatory research will be reviewed by human ethics review boards as part of standard academic practices. Indeed, it is for this reason that independent reviews are now common place within participatory medical research (Emanuel et al., 2000). To be most effective, independent reviews should be undertaken by multiple individuals throughout the scientific process, from the conceptual and design phase, through to the implementation of the research and the development of subsequent scientific outputs.

Independent reviews should not only be output focused, but also provide an evaluative mechanism on the overall functioning and dynamics of the team and various participants (e.g. Trimble and Lázaro, 2014). It is also important to ensure that reviewers are familiar with the processes and practices of participatory research so as to avoid having the project evaluated inappropriately based on a misunderstanding of the credibility of participatory research (as discussed in section 3.1) (Polanyi and Cockburn, 2003). Where independent reviews find that teams are not functioning effectively and risk has been created, steps should be taken to remedy the problem, by returning to the set of behavioural expectations agreed upon at the onset of the project, or if necessary, by drawing on the agreed conflict resolution mechanisms.

4.6. Reimagine professional development for adaptation researchers

While the above strategies are focused on practical steps that can be taken as part of the participatory research process, the challenges and risks can also be reduced and managed by reimagining professional development for adaptation researchers. For example, as highlighted in Section 3.2.3, the range of skills and experiences required to navigate and negotiate complex participatory processes are not taught as part of traditional academic training programs (Cvitanovic et al., 2015b). While academics in the social sciences are more likely to receive training in the participatory skills outlined above, training programs for natural and physical scientists to engage outside of academia are typically focused on improving one-way communication skills – opposed to those associated with active listening, mediation, brokering, facilitation and translation that underpin successful collaboration among diverse individuals/groups separated by epistemological perspectives (Addison et al., 2013; Bernsten et al., 2017; Bednarek et al., 2018). Thus, institutional innovation and structural changes within the academic system to support the development of these skills in adaptation scientists, and particularly with early career adaptation scientists, are needed (Lang et al., 2012).

This type of institutional innovation will not occur in a vacuum, but can build on recent advances in the past decades that promote transdisciplinary and participatory research. For example, there is an improved collaboration across disciplines and between science and society (Fischer et al., 2015). Funders are increasingly, albeit slowly, supporting participatory research and rewarding stakeholder engagement and practical impact. While these are still marginal trends, they are seeds of change that can stimulate broader transformation in the design of current research strategies and incentive systems that primarily reward disciplinary science that does not engage with society.

4.7. Ensure appropriate institutional support

Finally, the challenges and risks associated with participatory adaptation research can be managed and reduced by ensuring that appropriate and sufficient institutional supports are in place to protect both researchers and decision-makers. For example, participants in participatory research approaches should have access to formal legal and financial advice throughout the process of contract development to ensure that mechanisms are in place to protect their reputation, credibility and intellectual property. For example, prior to the commencement of research activity, contracts should be developed that clearly stipulate the conditions of the collaboration/partnership (e.g. the right to publish research outputs, the right to withdraw from the partnership should any conditions be not met, agreed upon conflict resolution measures, etc.) in order to protect the reputation and intellectual property of all participating individuals as well as their institutions.

Institutions should also explicitly recognise the additional challenges involved in implementing participatory research approaches, and ensure mechanisms are in place to support their staff should challenges arise, for example, via the establishment of formal mentoring programs. Finally, in light of the challenges and risks outlined above, and the time/resources needed to navigate them successfully so that desired outcomes can be realised, institutions (and particularly research institutions) should encourage good research practice by clearly defining and resourcing stakeholder engagement (Cvitanovic et al., 2015b). This should include incentivising this type of research through the establishment of adequate metrics of research impact that account for the full suite of responsibilities researchers have within participatory research approaches, so as to underpin promotions and career progression (Keeler et al., 2017)

5. Conclusions

Calls for the implementation of participatory research approaches have become commonplace in the pursuit of generating usable climate adaptation science that will be beneficially incorporated into decision-making processes. However, despite the many benefits of such research approaches, as we have highlighted through this review, their implementation also poses additional challenges for participants, in some cases with subsequent risks at personal, professional or institutional levels. These challenges, however, are not insurmountable, and in this paper we have drawn upon other sectors and disciplines where participatory research approaches are commonly implemented to start to identify strategies for managing these challenges, and reduce the risks they pose (outlined in Table 1). Underpinning all strategies is the central importance of relationships, trust, credibility and social learning, as researchers, practitioners, policy-makers and the broader community embark together on this new journey toward participatory knowledge generation and use. While the implementation of these strategies will need to be adapted to fit within specific contexts and processes, being mindful of the challenges associated with participation, and ways to manage them, will help enhance the benefits conferred through participatory research processes.

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